COMMONWEALTH OF PENNSYLVANIA.

DEPARTMENT OF AGRICULTURE.

BULLETIN NO. 59.

FUNGOUS FOES OF VEGETABLE FRUITS.

By Prof. Byron D. Halsted, Sc. D.

PUBLISHED BY DIRECTION OF THE SECRETARY.

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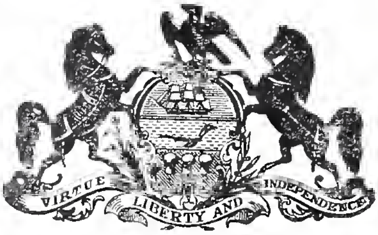
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COMMONWEALTH OF PENNSYLVANIA.

DEPARTMENT OF AGRICULTURE.

HARRISBURG, PA., *December 30, 1899.*

Our market gardeners are compelled to wage a continual war against insect and fungous enemies. These enemies are legion and sleepless, coming in myriads of spores which penetrate every crevice and attack all plants. To successfully combat these, science has discovered methods and explained their use. The present Bulletin treats of the "Fungous Foes of Vegetable Fruits," and was prepared by Prof. Byron D. Halsted, Botanist of the New Jersey Experiment Station. Professor Halsted has made a special duty of fungous diseases of plants, and is, therefore, a competent and reliable instructor in this branch of scientific agriculture. His work is commended to the careful study of all who are interested in vegetable gardening, and who desire to rid their plants of injurious germs which threaten the destruction of their crops.

JOHN HAMILTON,
Secretary of Agriculture.

FUNGOUS FOES OF VEGETABLE FRUITS.

By Byron D. Halsted, Botanist, N. J. Experiment Station.

Under the term "Vegetable Fruits" the writer has grouped those economic plants that are grown in the garden or truck farm for their fruits. They may be classified somewhat further by setting those of the tomato type by themselves, and then the melon class, and finally the pod fruits. In this way we have the tomato, egg plant and pepper as representatives of the first group, and, by the way, these are all members of the same natural family (Solanaceae) to which the potato belongs and with which they have some fungous diseases in common. The second assemblage, the vines, all members of the squash family, include the pumpkin, citron, watermelon, muskmelon and cucumber. Some of these furnish food in the green and others in the ripe condition; but all edible parts are as truly fruits as the apples, pears and other orchard tree-fruits or bush-fruits. The pod-fruits, as beans and peas, belong to the same (Leguminosae) and this includes the pea nut, although its fruit is dug or pulled from the earth at harvest time.

In short, a fruit is the product of a flower and it matters not whether it is upon a tree as a peach or cherry, or an annual herb like the tomato, or vine like the squash. The vegetable fruits may well bear the name given them because they are grown under the same general conditions as vegetables, strictly so called, and may be cooked and served like them. Thus, the squash may resemble turnips upon the dinner table, but the former is from a fruit, ripe or green, while the latter is from a fleshy root. The vegetable fruits have the seeds somewhere in the edible portion and with wax beans we eat them green with the pods, while in the case of peas the green plump seeds are separated.

As a rule the diseases to be considered in the following pages are common to both the foliage and fruit, and sometimes are propagated through the seed, as in the case of peas, beans and possibly melons and egg plant. A knowledge of the botanical nature of vegetable fruits is thus essential to the full understanding of their fungous foes.

FUNGOUS ENEMIES OF THE TOMATO.

There are several diseases of the tomato that are directly due to fungi that feed upon one or more portions of the plant. These fungi consist of fine threads or myriads of minute cells that grow in the tissues of the leaf, stem or fruit and rob them of the nourishment they have accumulated, and produce thereby an enfeebled growth that may result in the failure of the plant to mature its fruit or even in the death of the victim.

Some of these fungi prepare the way for the entrance of other of these forms of life that might not otherwise attack the tomato leaf or fruit, and in this way any destruction the true parasites might do is considerably enhanced. These latter will not be considered in the present paper, for space will only permit of a brief treatment of some of those that attack healthy plants.

The Tomato Leaf Spot. (*Septoria Lycopersici* Speg.).

The leading fungous enemy of the tomato in the Northern United States is the Leaf Spot. This fungus, *Septoria Lycopersici* Speg., is distinguished from all others of the tomato by the numerous small oval spots that it produces upon the affected leaf. A portion of such leaf is shown in Figure 1,* made from a sun print and, therefore, showing all details of leaf and number and size of spots as they existed. When the foliage is as badly diseased as the leaflet shown, the plant soon becomes bare and fails to produce fruit. The writer has seen whole fields that had gone down in early summer with this Septoria and only bare stems and a few small grown fruits were left, as shown in Figure 2 The stems, as well as the leaves, are attacked and when the leafless plants above mentioned are examined, minute spots

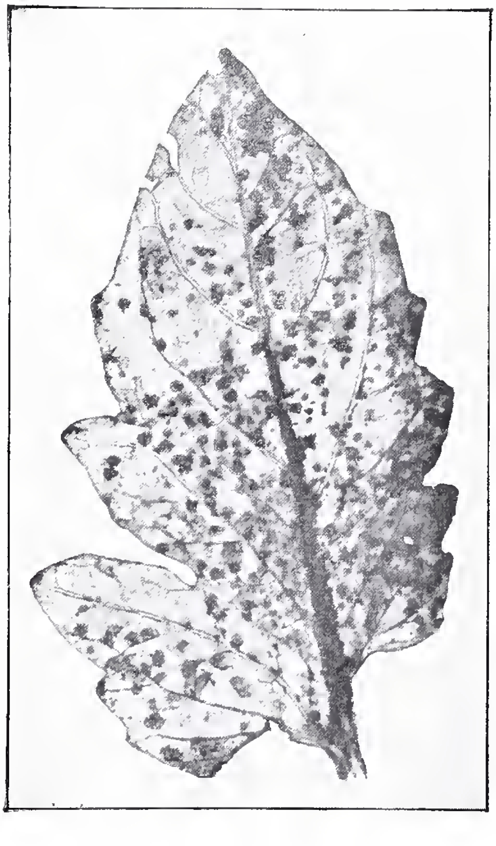

Fig. 1.—The Tomato Leaf-Blight.

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*This engraving and the other cuts of this paper are kindly loaned by the New Jersey Experiment Station, and the text is largely from the bulletins and reports of the Botanical Department.

may be found upon nearly all the stems, both young and old. In New Jersey as early as the middle of June, many fields met with are alarmingly infected with this fungus.

It seems evident from the facts above stated that the Septoria gains a foothold in the plants, while they are quite young. This is true in many instances that have been observed and the disease may, therefore, be taken to the field along with the tomato plants.

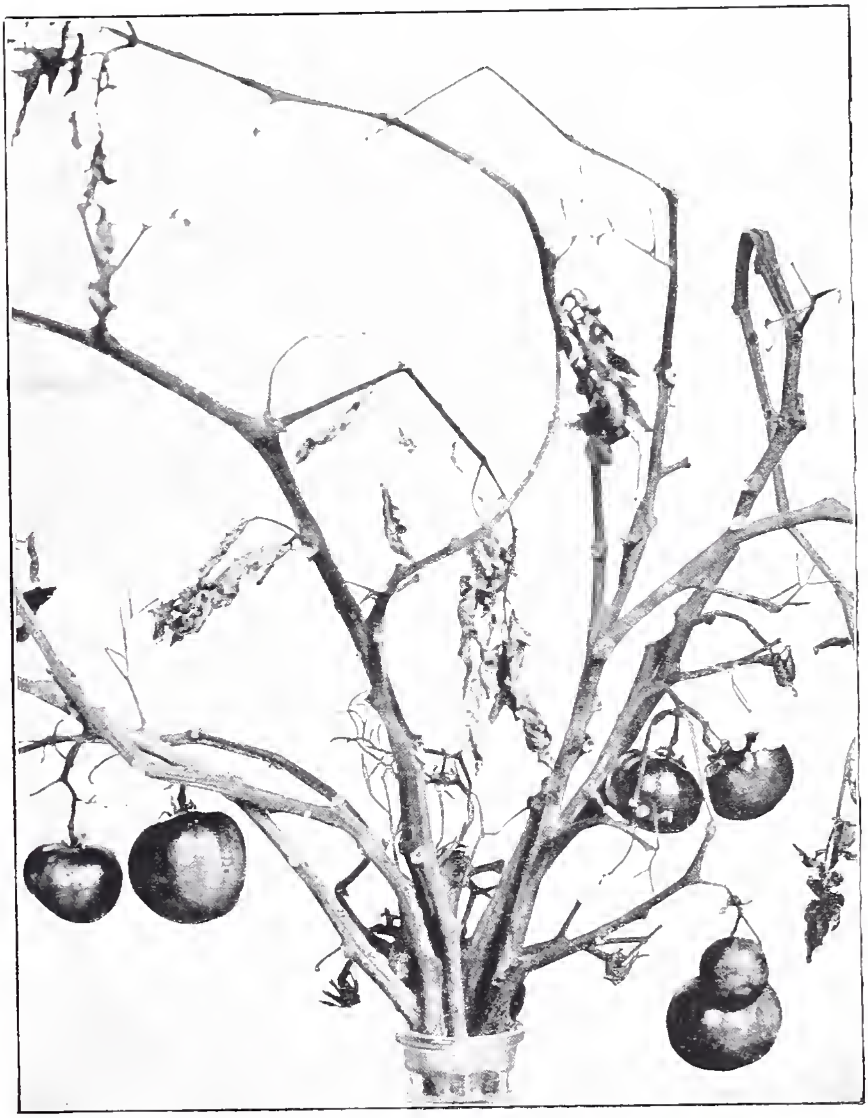

Fig. 2.—Tomato Stems Affected with Blight.

It was noted last season, for example, that one large propagator of tomato plants was the victim of much harsh criticism, because his plants failed in fields along side of plants of the same variety, procured elsewhere, that remained in leaf and fruited well. This seemed to be a case of infection in the propagating bed and suggests that as a precautionary measure against this pest, the greatest care should be taken in having everything connected with the production of tomato plants in strictly sanitary conditions.

The spores, produced in great abundance by the Septoria, will fall over or be washed down to the soil, and if they are capable in living over from one season to another the germs are at hand in abundance. It is, therefore, a matter of precaution to use a new soil each year, and to be particularly careful to use earth in the beds that have not previously grown tomatoes. As the stems become very much diseased, it is important that they be burned and not left in heaps to carry the disease over from one year to another. It is possible that trouble has arisen from the old stems having been thrown into the manure heap and thus the germs have found their way into the propagating bed. As a further precaution, the wood work connected with the beds might be sprayed with a fungicide or washed with lime. Better than this last is the action that at least one large grower of tomatoes is to take, namely, the abandonment of the old beds and all connected with them and the setting up of a new propagating establishment elsewhere upon his farm.

Growers of tomato plants will profit by acting upon the fact that the Leaf Spot is due to a fungus and that a bed or even a field may become infested with it. In fact, it is impossible that it may be a menace to whole sections of country where the crop can only be grown with profit when the strictest sanitary precautions are taken.

In 1896 the writer* made a field test of the danger of contagion from old plants by placing all the stems from a plot upon a strip equal to one-sixth of the whole plot and leaving them there through the winter. The stems were removed before plowing in the spring and the record shows that "tomatoes grown upon land upon which old tomato plants have remained during the previous winter are much more subject to attack from leaf fungi." The difference was not confined to the stems and leaves for there was also an excess of rotted fruits.

The Tomato Bacteriosis. (*Bacillus Solanacearum* Sm.).

A disease of a bacterial nature in tomatoes has been known since 1891. It is recognized by the sudden wilting of the foliage. This is soon followed by a change of color to a yellowish green that passes into brown, when the stems become shrivelled. When such stems are cut the bacteria oozes out.

This disease gas has been studied by Dr. E. F. Smith, and his results were published recently, and from the bulletin† some of the facts herein stated are drawn. "Probably the simplest way of distinguishing the disease is by the wilt of the foliage associated with a distinct browning of the vascular system, and with the presence in the vessels of myriads of bacilli. In early stages of the disease these are likely to be all of one kind, but later on many others may gain access to the plant and help to complete its destruction. When the disease is well advanced it may also be distinguished by the alkaline reaction of the juice when squeezed out upon litmus paper, the juice of healthy stems giving an acid reaction."

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*New Jersey Agricultural Experiment Station Report, 1896, p. 334-336.

†A Bacterial Disease of the Tomato, Eggplant and Irish Potato. Bulletin 12, Division of Vegetable Physiology and Pathology, U. S. Department of Agriculture, 1896.

This disease was first met with by the writer* in Mississippi, and on account of its locality and to distinguish it from other similar diseases, it was then named the Southern Tomato Blight. It is now known to be quite general in the Southern States† and has been found as far north as Washington, D. C., and it is not unlikely already in the tomato fields of the truckers around the cities of Philadelphia and New York.

The trouble is so obscure that it is not an easy matter to state definitely the losses that are to be attributed to this disease. The writer has seen large fields of tomatoes in the South where the diseased plants outnumbered those that were free from the wilt and blight. Again, it is difficult to estimate the damage of this enemy, because it is upon the potato and more widespread there than upon the tomato. Another host is the egg plant, and Dr. Smith has succeeded in inoculating the Jamestown weed, the black night shade and ground cherry, physalis and petunias. This shows that the bacillus has possibilities of thriving upon a long list of the species of the potato family.

As with the spread of other bacterial diseases of plants, much depends upon the foliage being kept with the skin unbroken. Anything that opens up a passage way from the atmosphere to the interior of the plant will render the inoculation all the more frequent.

The microbe may be transmitted from one plant to another by means of insects. Dr. Smith has been able to do this with the Colorado potato beetle in case of potato plants. The wilt characteristic of the disease appeared in the plants to which beetles had been brought that had been feeding upon foliage already containing the bacillus. The time of incubation was seven to nine days. It is not unlikely that any other insect that may be prevalent in a certain locality will be a leading agent in the transmission of the disease whether it be the flea beetle or any other insect that may be feeding upon the tomato plant.

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*The Southern Tomato Blight, Mississippi Agricultural Experiment Station, Bulletin 19, 1892.

†Professor Rolfs in Bulletin 21, "The Tomato and Some of Its Allies," Florida Agricultural Experiment Station, October, 1893, considers this a very serious trouble of tomatoes in his State.

The above remarks as to the injury to the protective skin of the plant and the liability of the disease being spread by insects, indicate strongly the nature of the chief preventive measures that can be suggested.

In the first place any plants in a field that go down with the disease, as recognized by the characteristics given above, should be removed and burned, and this is emphatically true of the plants that first show the disease, and, therefore, if left in the field will become centers of infection for the neighboring plants that might otherwise escape.

Secondly, all fields in which the disease may be expected should be treated in such a manner as to reduce the injurious insects to a minimum, first, that the natural barrier of the leaves and stems may be kept intact, and, secondly, that the insects themselves may not flourish and be the common carriers of the disease germs from the sick to the healthy plants.

It is a wise precaution not to grow tomatoes upon the same soil continuously, but instead, use land that has been in other crops for some years previous.

It may also be well if plants are purchased, to procure those that have been grown in localities exempt from the disease. Of course, if the trouble is very bad the growing of tomatoes will need to be abandoned for a time.

The Fruit Rot or Black Mould. (*Macrosporium Tomato* Ck.).

The disease known as the Fruit Rot, Black Mould or Fruit Mould as the names suggest, works upon fruit. It usually begins at the blossom end and spreading from there sometimes causes the decay of the entire fruit.

This fungus is usually accomplished by other fungi *Fusarium Solani* Mart, being one of these, so that it is difficult to determine how much of the destruction of tomato fruit is finally due to the Macrosporium. Whether alone or in combination, the losses resulting are heavy and the method of attack and conditions of growth are worthy of attention.

As a rule, the blossom end is the weak point in fruit, and the tomato proves no exception. It is also often true that the fruit when borne low, gets upon the ground and usually the free or blossom end is next to the earth. The presence of germs upon the soil and the moisture of their presence are sufficient to account for the increased blight; but in addition to this is the nature of the surface of the fruit at this point, which is more or less roughened and imperfectly covered with the true skin, and, frequently, the dried flower remains for some time and gives lodgement for the germs, and a suitable place for their growth. This latter statement accords with the facts in the case, for the rot begins at any time after the fruit has begun to form and seems to be worse with the rough skinned tomatoes than with those having a smooth exterior. As a rule those varieties with a decidedly imperfect blossom end, that is, more or less made up of indentations and irregular cavities are most inclined to rot. These latter fruits being weak at the free end frequently crack and then the natural barrier against the fungi is destroyed, and they soon cause a rotting of the fruit. It may, therefore, be said in passing, that those varieties characterized by smoothness of exterior, particularly at the blossom end are, other things being equal, the ones to be selected from the standpoint of resisting the decay germs, as well as for their good appearance and for the economy in preparing them for the table.

It is a matter of fact that the structure of the fruit has considerable to do with the abundance of fruit decay. This is shown in the results of a test with seven quite widely separated sorts grown by the writer* in a trial ground. The little "Red Cherry" had almost no decayed fruits, while the "Peach" rotted quite badly. The latter is a soft, flabby fruit with a rough skin, from the color and texture of which it gets its name. The "Trophy" rotted twice as badly as the "Dwarf Champion;" but here the difference is probably not so much in the fruit as the more upright habit of the "Champion," that tends to keep the fruits above the soil.

Professor Galloway† made some tests of fungicides for the Black Rot, and found the Bordeaux mixture a satisfactory remedy, as the treated plants gave only 4 per cent. of rotten fruit to 60 per cent. upon the adjoining untreated plot.

The writer has never obtained such favorable results for spraying from the fact that he has failed to have a large percentage of decay upon any part of the field. With the Leaf Spot, however, there has been enough reward to warrant a hearty recommendation of spraying for tomatoes.

Professor Beach‡ mentions a disease, with a full page plate, that is quite similar to the Black Rot in that it usually appears at the blossom end of the fruit, being at first brown, with a leathery texture and with the absence of any fungus threads. It does not attack the leaves and is most abundant upon the "early fruits of rapidly growing plants." Old specimens become attacked by common blue moulds and other similar fungi.

Very recently a new fungus upon the tomato fruit has been discovered by Mr. E. Bartholomew, in Kansas, and described under the name of *Helminthosporium Tomato* E. and Barthol.* This is a true black mould somewhat closely related to the *Macrosporium Tomato*, Cke. The amount of damage this fungi does has not been determined.

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*New Jersey Agricultural Experiment Station Report, 1897, pages 286-292.

†Experiments in the treatment of Tomato Rot. U. S. Department of Agriculture, Sec. Veg. Path. Bulletin 11, 1889, pages 61-65.

‡Forcing tomatoes, etc., N. Y., Agricultural Experiment Station, Bulletin 125, 1897, page 305.

A leaf mould due to *Alternaria Solani* (E. & M.) Jines, is mentioned by Professor Jones† as destructive to the foliage of the tomato.

The Tomato Anthracnose. (*Colletotrichum phomoides* (Sacc.) Chester).

One of the leading fruit diseases of the tomato is the anthracnose or Fruit Spot, due to the fungus *Colletotrichum phomoides* (Sacc.) Chester.‡ One of the characteristics of this disease is its attacking the maturing fruit and causing it to become sunken in minute saucer-shaped places that increase in size and deepen until the fruit, when in a badly anthracnosed condition, is full of deep pits and very angular in outline. Four fruits thus affected are shown in Figure 3. This disease has been present in small amount during the past four years upon the experiment grounds in charge of the writer and spraying with Bordeaux and other fungicides, while checking it somewhat, have not given the relief hoped for. Until it becomes more serious that at present the anthracnose will not demand special attention.

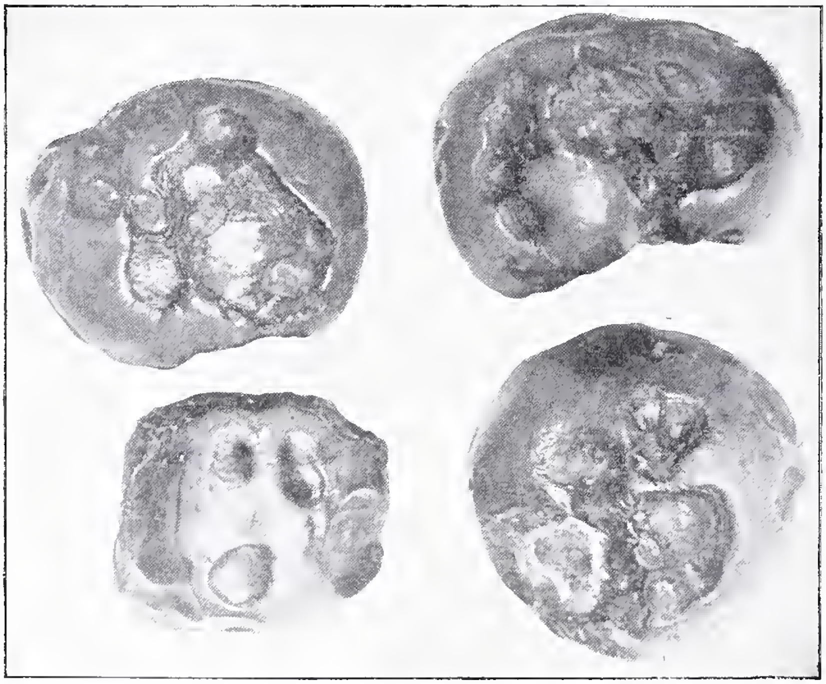

Fig. 3.—The Tomato Fruit Anthracnose.

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*Bulletin Torrey Botanical Club, October, 1897, p. 473.

†Report of Botanist, Vermont Agricultural Experiment Station Report, 1896, page 45.

‡Delaware Agricultural Experiment Station, Report 4, 1891, pp. 60-62.

It is to be noted that any spraying for the Septoria or other disease of the tomato will help to check this one. It is widespread throughout the country, Professor Selby* illustrating it along the *Septoria Lycopersici* already mentioned.

The Tomato Cladosporium. (*Cladosporium fulvum*, Cke.).

A common fungus disease of the tomato, particularly in greenhouse culture, is caused by *Cladosporium fulvum*, Cke. It is quickly recognized by the brownish or pale olive colored irregular patches upon the underside of the leaves due to the dense felt of fungous threads and the spores which they produce in great abundance freely upon the surface. Later in the development of the fungus the infested areas become brown and the leaf tissue dies. This blight spreads with great rapidity and often does much damage to the foliage and spreads to the fruit, which likewise quickly rots. The writer† determined that the spores from the leaves, when introduced into green tomatoes, would quickly cause their decay.

As before stated, the leading trouble with this fungus is usually with tomatoes under glass, and here the spray pump should be used in a most thorough manner, the nozzle being held so that the liquid is certain to reach the underside of the foliage. Any discoloration of the fruit is not serious as it can be cleaned, if desired, before they are sent to market.

Dr. Sturgis‡ considers insufficient circulation of air as one of the leading factors in the spread of the Cladosporium and, therefore, in addition to spraying, advocates the training of the plants up trellises to keep them above the moist surface of the ground, together with "pruning away of all the lower branches * * so as to allow the free access of sun and air."

Conclusions.

From what has been written under the heading of Fungous Enemies of Tomatoes, it seems clear that these troubles are sufficiently important to demand the attention of the growers. As they are low forms of fungi they spread by means of spores and attack the tomato plants at any time during their growth.

Some species appear in the propagating bed and afterwards spread fatally in the field upon the foliage and stems. Others attack only the fruit and most frequently as it nears maturity, rotting the crop while upon the vine. These latter fungi continue to breed decay in the fruit after it is in the market and prepare the way for innumerable accompanying forms, so that fruits that are only slightly diseased at picking are soon decayed and worthless.

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*Ohio Agricultural Experiment, Bulletin 73, December, 1896.

†Proceedings of the Society for the Promotion of Agricultural Science, 1883, page 42.

‡Common Fungous Diseases and Their Treatment, Conn. Agr. Exper Sta., Bull. 115, p. 1893, page 16.

It has been shown that the old stems are harbors of the fungous pests and should be burned in autumn. The soil received the germs that fall upon it or are washed down by the rains, and, therefore, it is not advisable to grow tomatoes continuously upon the same land. Likewise, if disease is prevalent, it is best to change the surroundings of the propagating bed occasionally.

The tests made with fungicides, generally show that tomato fungi can be held in check by spraying; both as regards the forms confined to leaves and stems. Septoria, and those which feed upon all parts—Cladosporium, Macrosporium, or the species that are usually met with upon the fruit only—Colletotrichum.

Some growers feel that it pays to place brush under the vines to keep the fruits from the soil, and thereby prevent their decay.

For a spray there is nothing superior to the Bordeaux mixture, and it can be used in all its usual strengths and modifications without harm and with satisfactory results. In tomato culture under glass the removal of diseased parts may supplement the frequent use of the fungicide.

FUNGOUS ENEMIES OF THE EGG PLANT.

Of late years troubles have arisen among the egg plants, and several fungous enemies have been found upon the diseased plants, and frequently these are so intimately associated that any definite amount of injury cannot always be ascribed to a particular form of fungus. All parts of the egg plant are subject to the attacks—some of the parasitic enemies working upon the roots, others upon the stems, while still others prey upon the leaves or are confined to the fruit. It is likewise true that some species thrive upon two or more members of the plant body, as, for example, stems and leaves, or leaves and fruit. The most natural method of considering these diseases, will be to take them in the order of their occurrence in the development of the egg plant.

"Damping Off," or Seedling Stem Blight. (*Phoma Solani*, Hals.).

The first annual complaints come from those who lose a percentage of their plants while they are in the hot-bed. The truckers speak of this trouble as a "damping off," because it is located near the ground, and at that point the young stems decay and may break down. Plants only slightly affected will continue to make a feeble growth but may finally lose their green color and become worthless. Such plants, when carefully examined, show a portion of the stem dead near the surface of the ground. Many examples are found of plants that seem to be entirely girdled by the fungus, together with the dead substance which it has killed.

The diseased portion is much smaller than the stem above it, due partly to the drying out and shrinking of the diseased tissue, but mostly to the arrest in the development of the stem where the fungus is present. The fungus that causes the death of the subject, is so small that without the aid of a microscope nothing more is seen of it than a number of black specks imbedded in the substance of the diseased portion. The dark spots upon the stem are spaces where the fungus threads have formed multitudes of spores, inclosed in a dense mass of the surrounding substance. When the spores are mature, an opening is gradually formed near the middle of the exposed part, and the contents may pass out, when swollen, by the absorption of water. When such a dry surface is wet, the spores often pour out in a stream for some time. These spores are designed to spread the disease, and, therefore, all such affected plants should be burned.

Spores, as a rule, can be killed or prevented from growing by various substances, and, therefore, one or more of these could be employed in the hot-bed to check the ravages of the disease. It is possible that the fungus germs are sometimes accidentally attached to the egg plant seeds, and sown with them, or it may be that the fungus has even entered the seed and begins at once to develop when to seeds start to germinate. If such be the case, it is possible that a soaking of the seeds in a fungicide before sowing may prove of value.

The Leaf-Spot Fungus. (*Phyllosticta hortorum*, Speg.).

The fungus that causes large brown and lifeless patches in the leaves is one that has been known for a considerable time, but that it does considerable damage directly to the fruit, is a recent fact. Figure 4 shows this species, and it is one that is easily recognized. At *a* is shown a young fruit that is attacked; there are three diseased patches, one of which is a union of smaller ones. Upon all, the small specks are shown as occupying the surface of the center of the affected areas. A leaf, also reduced in size, is shown at *b*, with several of the dead patches, and some of them broken, and portions of the brittle substance fallen away. The similarity between the diseased patches of the fruit and leaf is quite marked, but owing to differences in the tissues affected, there are minor points in which they necessarily are not alike. However, the spores, shown at *c*, are practically the same, and furthermore, there is no difficulty in successfully inoculating healthy fruit with spores from the diseased leaves, in two days. At *d* are shown some further details of the spore-bearing bodies and in the manner in which the spores escape from them in long, often much-soiled threads, held together by an enveloping slime.

The crop is particularly well adapted for the application of remedies, as the spraying can begin in the hot-bed and be continued in the field during the growing season. As the leaf spot and fruit rot disease follows closely upon the "damping off," it is evident that the fungicide applied for the latter, will also answer for the former. It may be necessary to spray, say once in two weeks, from the time the seedlings appear until the crop is harvested. To those who may take no active means to check the ravages of the disease, let it be said that decayed fruit when left in the field becomes the propagating places of the disease. As each maturing pimple contains a vast number of spores, therefore, it is a wise precaution to gather all such worthless fruit from the ground or plants and burn it, and if the diseased plants could be bodily consigned to the fire, the next crop would be less infected. As one of the best methods of ridding a field of weeds consists in letting none go to seed, so fungous enemies are dealt a severe blow when they are not left to run riot upon a crop that they have ruined. If spraying is neglected, the next best thing is to destroy the decaying crop, just as the gathering up of weeds in autumn and burning them is better than leaving the seeds to propagate their kind.

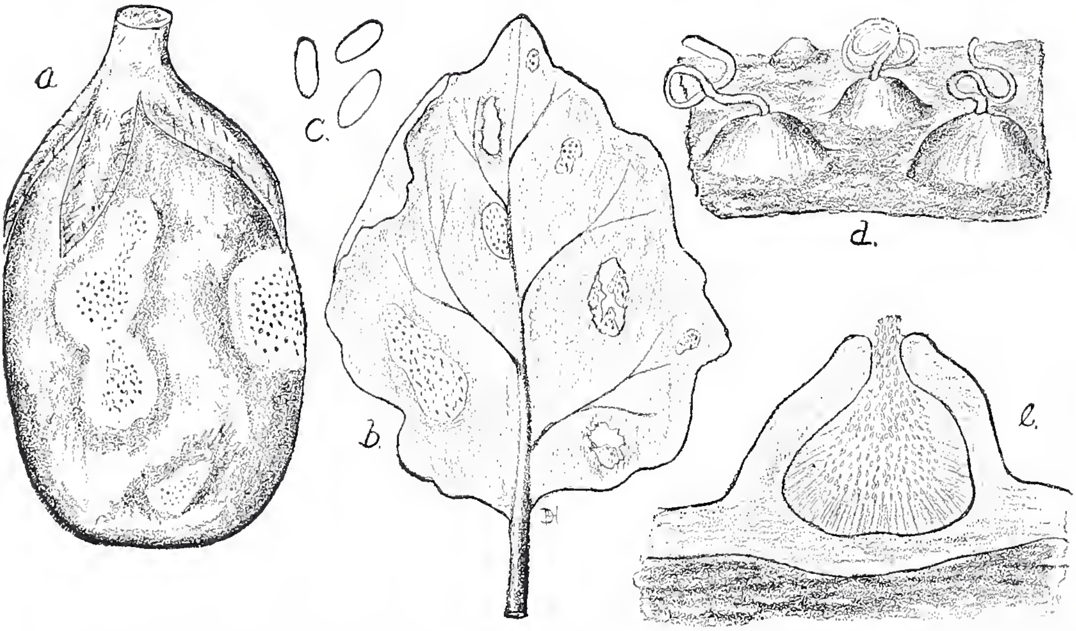

Fig. 4.—Eggplant leaf spot; *a*, affected fruit; *b*, diseased leaf; *c*, spores; *d*, surface view of same; *e*, magnified view of spore vessels.

The Egg Plant Stem Rot. (*Nectria Ipomoeae*, Hals.).

The fungi already mentioned, while they account for a large part of the decay among egg plants, do not embrace the worst of all. There have been whole fields ruined where scarcely a fruit has been gathered, and with rarely the leaf-spot apparent in foliage or fruit. In these fields the plants take on, when half-grown, or later, a yellowish, sickly appearance, and with the foliage wilted and the lower portion of the stem whitish with a mould, the plant finally dies without issue. Frequently the struggle for life is more prolonged and some fruit is borne, but sooner or later the plant succumbs to the enemy. When such plants are pulled from the soil it is found that a fungus has been at work near the root, and the character of the enemy is determined by the numerous minute pink bodies that are clustered upon the decayed surface. The fungus is a species of nectria, and each of the pink bodies is a vessel in which sacs containing spores are produced in great numbers.

A nectria was found by Professor Galloway upon the sweet potato. Its association with the stem rot has been noted, and upon comparing it with the one upon the egg plant, the two agree in microscopic details. It still remained to obtain the proof of identity that comes from cultures.

In the case of sweet potato, it has been observed for some time that the fusarium was always present upon a vine dying with the characteristic stem rot. The seat of attack is at or near the surface of the ground and spreads both towards the end of the vine and downward into the roots. In the same manner the stem rot of the egg plant begins at or near the surface of the soil and spreads both upward and downward. The differences that are apparent as to the behavior of the two pests are easily accounted for by the unlikeness in the habits of the sweet potato and egg plant. One is a prostrate plant with small stem, no large development of woody tissue and with large, fleshy roots, while the other is upright, with a decidedly wood stem and no large, succulent roots. The point that will attract the attention of those who have made a special study of fungous diseases, is the fact that the two plants attacked are not close to kin. They belong to different natural orders, and it is not usual for a parasitic fungus to prey upon plants that are not quite closely related. However, there are many exceptions to this rule.

Root-Gall of Egg Plant.

An examination of the roots at the time of harvest may show that they are infested with nematode worms, and in some cases the galls are quite noticeable, a sample of which is shown in Figure 5.

Nematodes occur in ornamental plants, as bouvardia, coleus, chrysanthemum, lantana, rose, ferns, moonflower, pelargonium, salvia, zinnea, ficus and violet. In a large number of the above cases the worms were found in the foliage, where they caused a browning of the tissue and the ruin of the infested leaves. Notable exceptions to the foliar nematodes are those producing root galls upon the rose and violet, where these parasites do a large amount of harm.

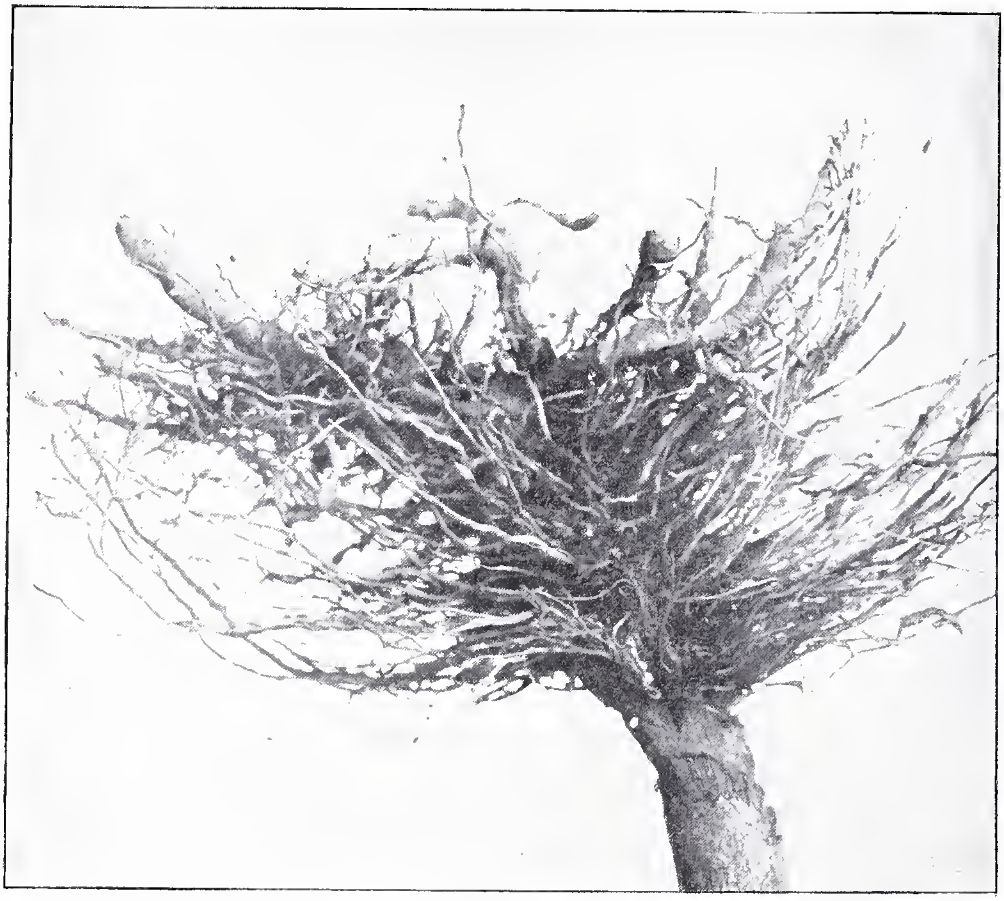

Fig. 5—Roots of Eggplant Affected with Root Galls.

In the Southern States the nematodes are much more abundant than with us, the cold of winter being destructive to them at the North. Professor G. F. Atkinson,* then at the Alabama Experiment Station, made a study of the nematodes and listed thirty-six plants that were attacked as observed by him in Alabama. Among these are the following truck plants in the order given: Potatoes, egg plants, tomato, okra, bean, watermelon, citron, beet, cabbage, turnip, parsnip, lettuce and salsify. The Northern growers of these plants may be thankful that their crops are generally uninjured by these worms, the scientific name of which is *Heteroderma radicicola* Müll.

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*"Nematcde Rcot Galls," Bulletin No. 9, Alabama Experiment Station, December, 1889.

Should the crops of the colder regions become infected seriously, the land might be laid down to grass, or ridging for more thorough exposure to the elements in winter might prove effective. As yet, our greatest injury is done to tender plants grown indoors, as roses and violets.

FUNGOUS ENEMIES OF PEPPERS.

Early in the season, the fruit of the peppers often began to be attacked with an anthracnose, causing soft patches that exhibited rifts in the skin, through which the spores appeared in great abundance. This is *Gloeosporium piperitum*, E. & E., a species that Mr. Ellis first found in the Vineland, N. J., markets about ten years ago.

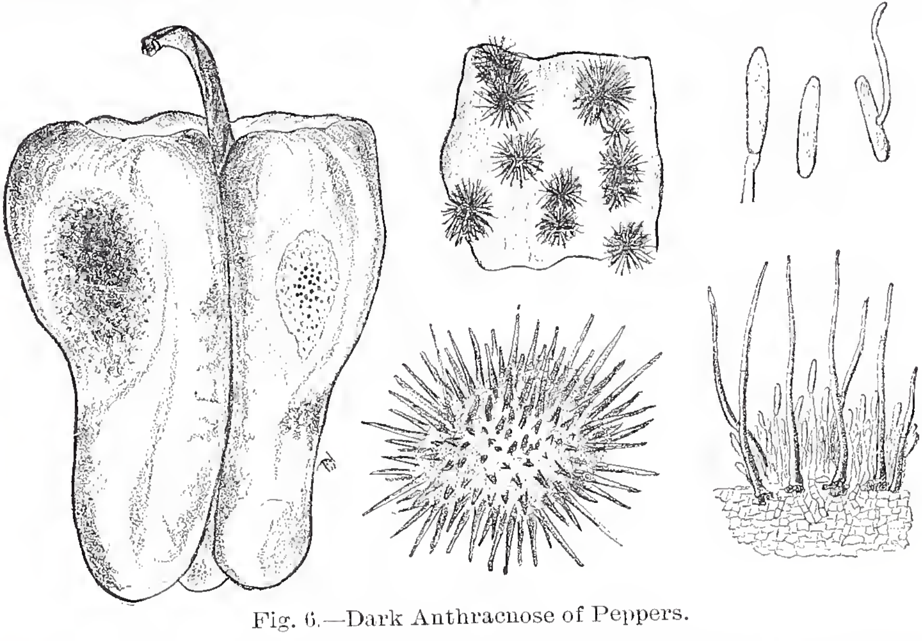

Fig. 6.—Dark Anthracnose of Peppers.

A second species of anthracnose belonging to a genus very closely related to the above, is shown in Figure 6. This forms decayed patches also in the young and ripening fruit, but instead of the color remaining unchanged it turns to a decided black, the color being due to the multitudes of dark bristles that are interspersed with the colorless spore-bearing threads. In Figure 5, upon the left, is shown a pepper with two affected patches, the larger and darker being the older. In the upper center of the engraving is shown a magnified portion of the dark diseased patch with the dark rosettes. A single cluster is shown below, still more highly magnified, and a thin section through the same indicated in the lower right-hand corner. The spores still more enlarged are seen just above.

A third species of fungus was found upon the foliage, only, of the pepper, in several localities, and while some plants were evidently weakened by it, as a general thing the effect is not deleterious. In this the affected leaves become marked with small circular spots of an ashy color, over which are small black pits bearing multitudes of colorless spores. It is a member of the genus *Phyllosticta*, which contains a large number of the so-called leaf-spot fungi, some of which are very destructive.

FUNGOUS ENEMIES OF THE CUCUMBER AND MELONS.

The first disease to be considered here is a genuine downy mildew (*Plasmopara cubensis* (B. & C.). This is a fungus closely allied to the American mildew of the grape, and is first cousin to mildews of lettuce, spinach, onion and the still more dreaded rot of the Irish potato. It is in the midst of a destructive group, and much damage

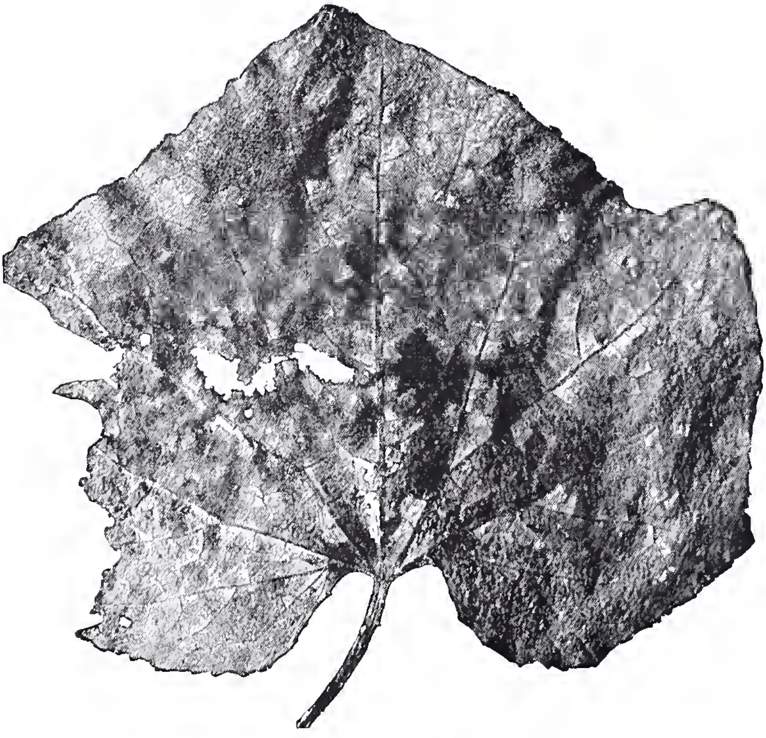

Fig. 7.—Cucumber Leaf with Mildew.

may be expected from it. Until ten years ago this species was scarcely known in the United States. At that time it was observed upon cucumber vines growing in greenhouses, but since then it has been found doing injury to the squash, pumpkin, watermelon and muskmelon. The cut (Figure 7) is an engraving from a photograph of a cucumber leaf, which was selected instead of a muskmelon leaf because it, from the nature of the smooth surface, showed the attack areas far better than the foliage of the muskmelon. The fungus is the same, but upon the rank growing and comparatively smooth, thin foliage of the cucumber the trouble can be recognized at a long distance. The mildew has the peculiarity of growing angular patches, which sometimes occupy half of the area. The spore-bearing tufts of threads pass out the stomata upon the under side of the leaf and form a frosty covering, which later turns to an almost violet tint, due to the multitudes of spores, of the strongly colored. This violet color of the spores seems to be more highly developed in the mildew that is upon the squash than upon any other of the cucurbitaceous hosts. It would need several engravings showing the anatomy of the parasite to fairly present the manner in which the threads of this fungus penetrate the tissue of the leaf and rob it of the

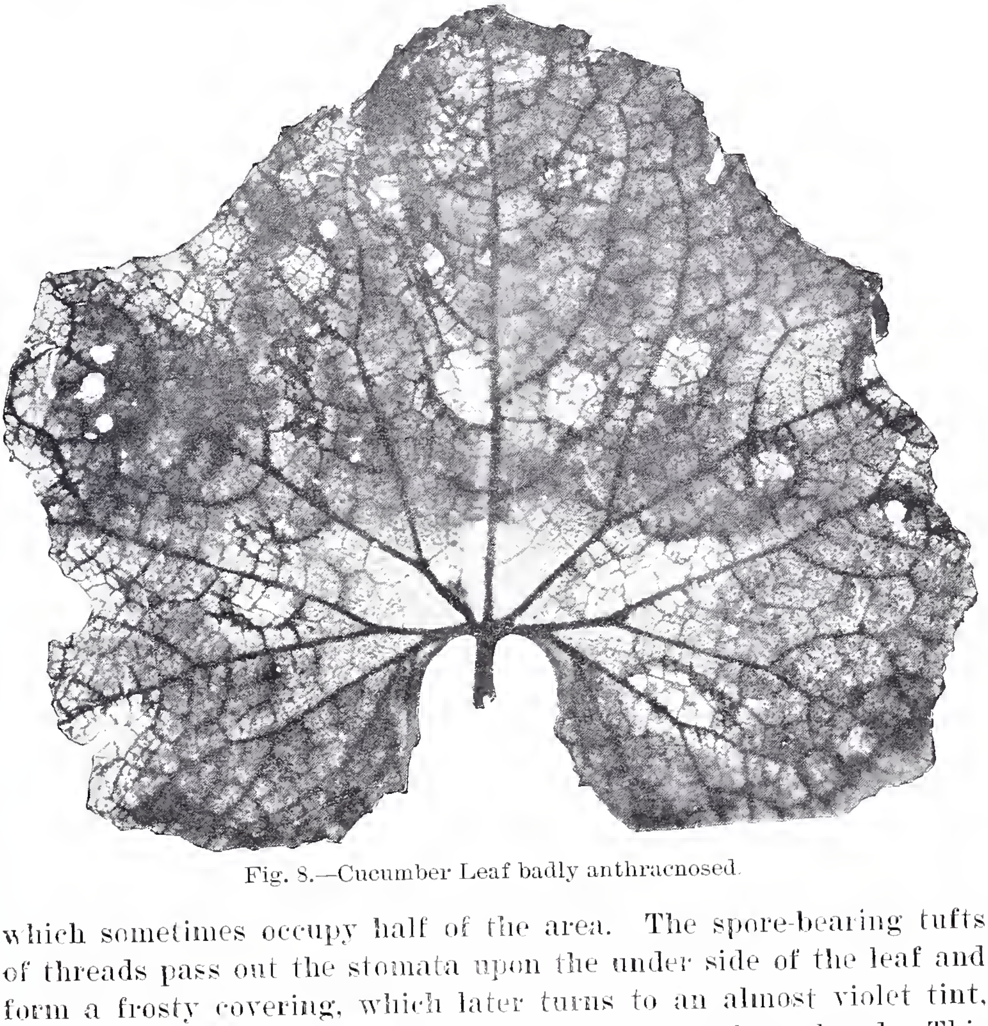

Fig. 8.—Cucumber Leaf badly anthracnosed.

desired nourishment. Success has attended the use of fungicides upon this trouble of the cucumber, the Bordeaux mixture being the most effective.

Figure 8 shows a cucumber leaf that has been in large part destroyed by an anthracnose. The specimen photographed for the engraving was collected along with hundreds of others in a field where the crop had been almost ruined. The fruit is also affected and Figure 9 shows a cucumber (engraved from a photograph), that, while still plump, is made worthless before removal from the vine. It is of interest to state in this connection, that the anthracnose often attacks and destroys the fruit as it is brought from the South. Dealers sometimes lose heavily by this decay of the fruits.

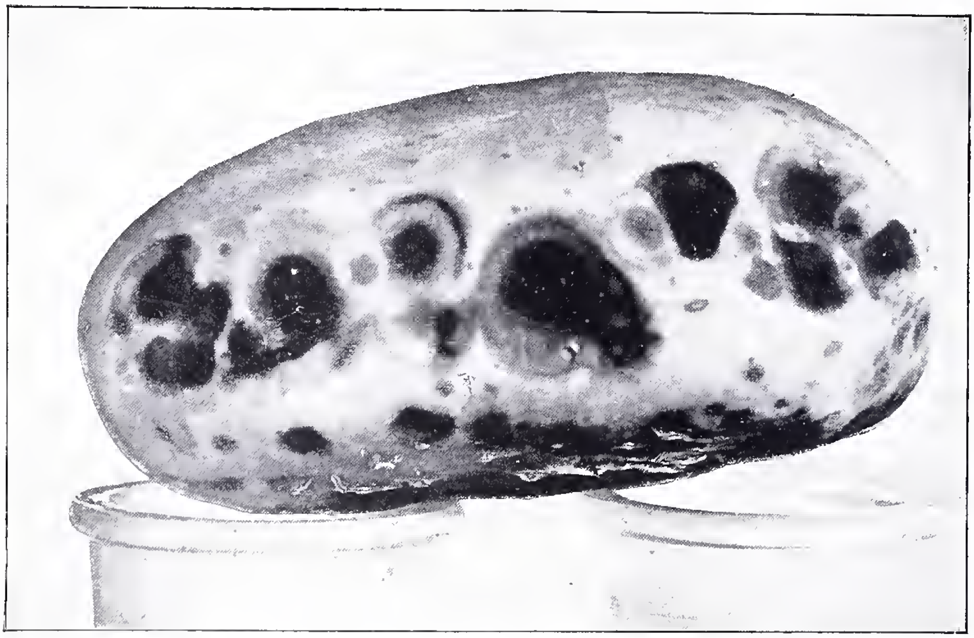

Fig. 9.—A Cucumber with Anthracnose.

The same anthracnose makes sad havoc in the watermelon fields during some seasons, causing the foliage to become spotted and turn brown, while the fruits have deep ulcers in their rinds filled with a pinkish mass of the spores. A photograph does not do full justice to this trouble and the engraving made from such is still less satisfactory. However, Figure 10 will give the reader some idea of the appearance of a badly anthracnosed watermelon much reduced in size.

The muskmelon and the citron and squashes are likewise affected, but the thicker rind helps to check the rapid course of the disease as met with in the watermelon. Sprayings help greatly in this instance.

The Watermelon Wilt.

This is one that has been complained of from all parts of the country, and especially in the South. It is not easy to describe the appearance, for no two plants were alike. Soon after the plants are up, usually by the time they have reached out a foot or so upon the ground, the trouble begins. The stem may become moist in a manner to suggest what is termed "water core" in apples. This may be close to the base of the plant or midway between that point and the tip of the vine. Professor Smith, of the United States Department of Agriculture, finds this due to *Fusarium niveum* which enters the plant through the soil and fills up its water conducting system, causing sudden wilt and subsequent death. The fungus lives over winter in the dead stems and grows readily in manure. Unwittingly, a man may make a hot-bed of his manure pile where he deposits the raking of a melon field, and afterwards place the infected dung in the hills of the new melon fields. This is a striking illustration of how a disease may be continued and actually introduced into land before free from it. The manure pile is one of the most successful means of the propagation and spread of plant diseases of the farm and garden.

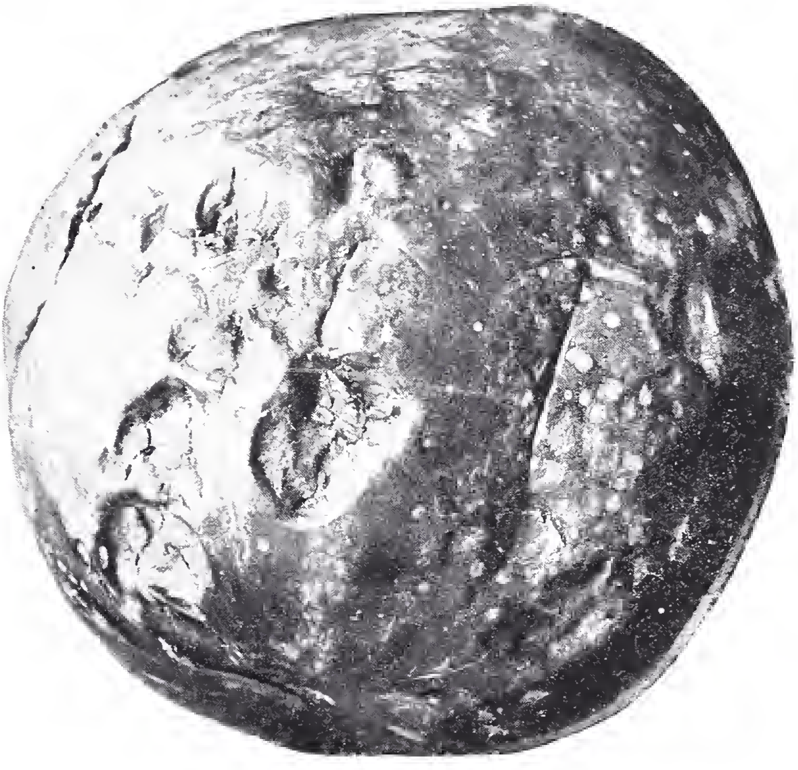

Fig. 10.—Anthracnose of Watermelon.

FUNGOUS ENEMIES OF BEANS.

The anthracnose or "pod-spot" of the bean has been known for many years, and treatment of the subject may be found in nearly all works that deal with parasitic fungi, and particularly of those affecting cultivated plants. It is not the purpose here to more than mention some points of observation in connection with it, and suggest a feasible method of reducing the amount of this serious trouble among market gardeners.

The fungus (*Colletotrichum Lagenarium* (Pass.), most frequently attacks the pod of the bean (Figure 11) when they are only partly grown, and, causing the formation of deep, dark pits, materially lessens the yield of salable beans from the field infested. The disease spreads rapidly from pod to pod in the market place, as has been shown by repeated inoculations in the laboratory, where, under the most favorable conditions, a spot may be established upon an otherwise healthy plant in thirty-six hours.

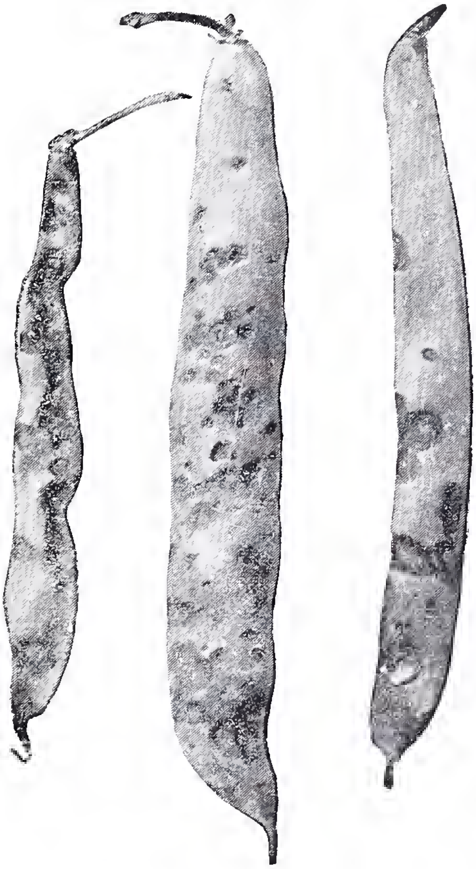
Fig. 11.—Anthracnose of Bean.

The manner in which the fungus passed the winter has been one of the points under consideration. While the colletotrichum is likely only a form species, it is not known what other conditions it passes through in its life circle. Therefore, until another form can be demonstrated, it is necessary to temporarily consider it as now known as complete. If this be assumed, it is well to note any possible condition in which the collectotrichum can exist through the winter or from one growing season to another. This we find to be in the mature beans themselves, and when these diseased seeds are used for planting, the anthracnose is given the best possible conditions for its own perpetuation and, therefore, for the spread of the disease through the field.

Beans of various sorts were examined for the presence of the anthracnose, attention naturally being paid to the seed that exhibited an unhealthy condition. It was found that a large percentage of some lots of the wax sort were defective, and particularly in the region of the "eye." Instead of the natural color and plumpness, the pods were brown and wrinkled. When such beans were split open the brown or rusty appearance would be found extending half way through the seed. By placing such imperfect beans in a dish in a moist chamber and keeping them moist, a rank growth of the anthracnose quickly developed upon the diseased parts of the beans and rapidly spread over the healthy portion of the seeds. The spore-patches were so abundant as to almost completely cover the surface of the beans and the spores developed in countless numbers. As a rule, bacterial fermentation soon after set in and the small heaps of halved beans became exceedingly offensive masses of decay. This only goes to show that the bean seeds are very rich in those substances enjoyed by the fungi, and, therefore, a rapid and a wholesale development of the anthracnose is only to be expected.

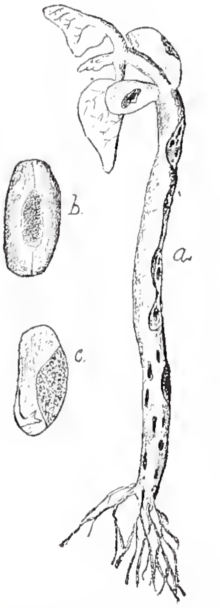

Fig. 12.—Anthracnose of bean seedling *a*; whole bean, with spot, *b*; and a half of diseased seed at *c*.

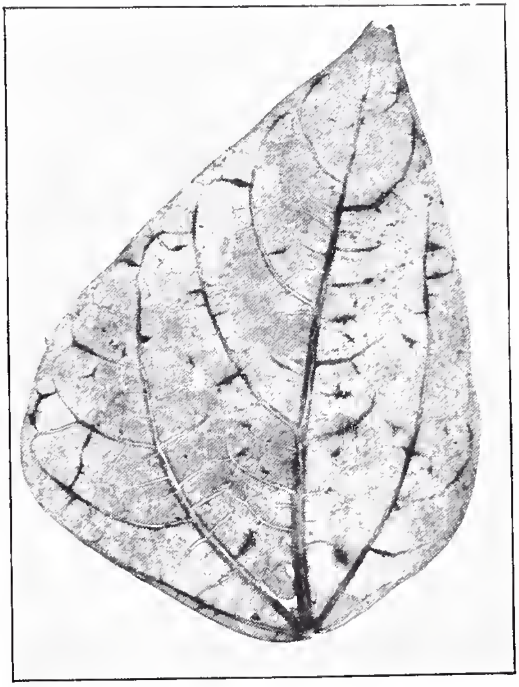

Fig. 13.—Anthracnose of Bean Leaf.

In Figure 12 is shown a seedling bean; *a*, with the stem and seed leaves badly blotched with the pod spot fungus. At *b* is seen a picture of a diseased bean and at *c* is shown a half of a bean with the affected portion shaded.

A more careful examination of the diseased beans when first split and before they had remained for a time under favoring conditions of warmth and moisture, showed that the surface in some instances was already studded with the spore masses, these demonstrating that the dry beans, as found in the market and seed stores in early spring may not only be infested with the anthracnose, but still more, are bearing spores upon the inner surface of the cotyledons, where, by the natural shrinking of the seed, a considerable cavity is often produced. The appearance of the fungus upon the leaves is shown in Figure 13, where the darker lines, usually associated with the venation of the leaf, represent the most affected parts.

Identity of the Anthracnose of Cucumber and Bean.

This point, while of interest to the student of plant diseases, has its strong bearing upon crop production. The writer was able, by inoculation, to transfer the disease from the bean to representatives of the cucumber and melon family as, for example the citron, not in itself particularly susceptible to the disease. In short, the record in brief of the results runs as follows: It was not difficult to transfer the watermelon anthracnose to the bean. But the points

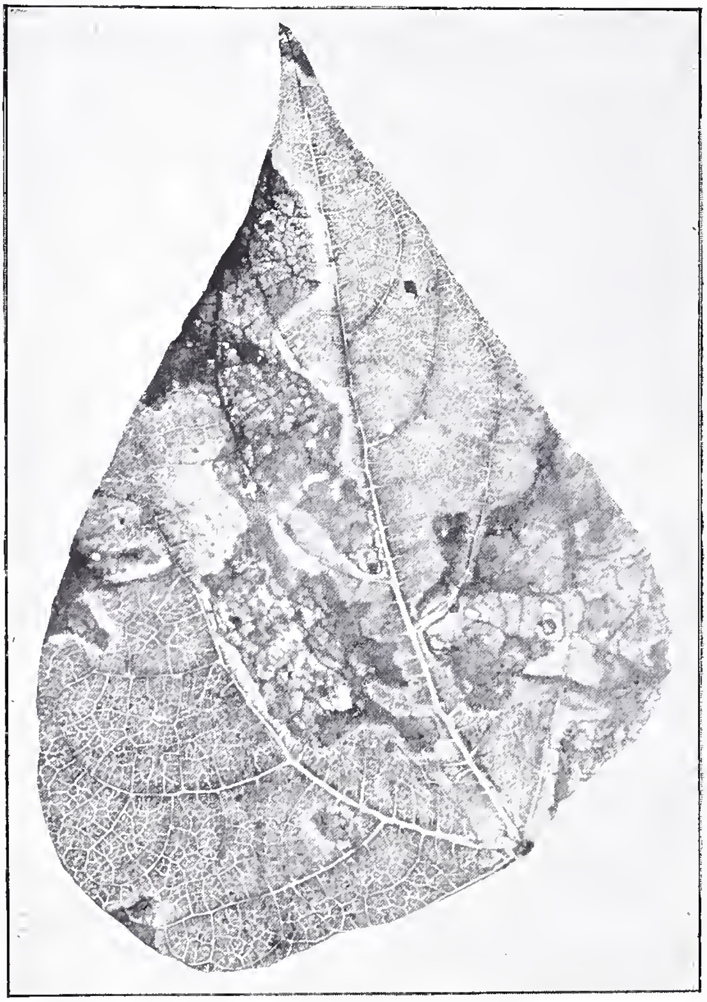

Fig. 14.– Bacteriosis of Bean.

that may be of interest were the results with a third fruit, because admitting of parallel inoculation for both the bean and the watermelon.

Citrons small enough to go under a medium-sized tall bell-jar were selected, and at first inoculations were made from the watermelon, here and there, under the skin of the citron, the virus taking quite uniformly and growing luxuriantly.

The Colletotrichum virus was taken from the bean and applied to the citron at a few points upon the side of an ink line drawn lengthwise of the fruit, while similar inoculations were made from the watermelon on the other side. Both grew with about equal rapidity, and when prolonged, the results blended, showing identical results. In short, the appearance to the naked eye was the same, and the microscope showed no differences. The work was repeated with uniform results.

Bacteriosis of Beans.

The disease above named is due to a micro-organism and is sometimes one of the worst enemies to the bean. It was first observed

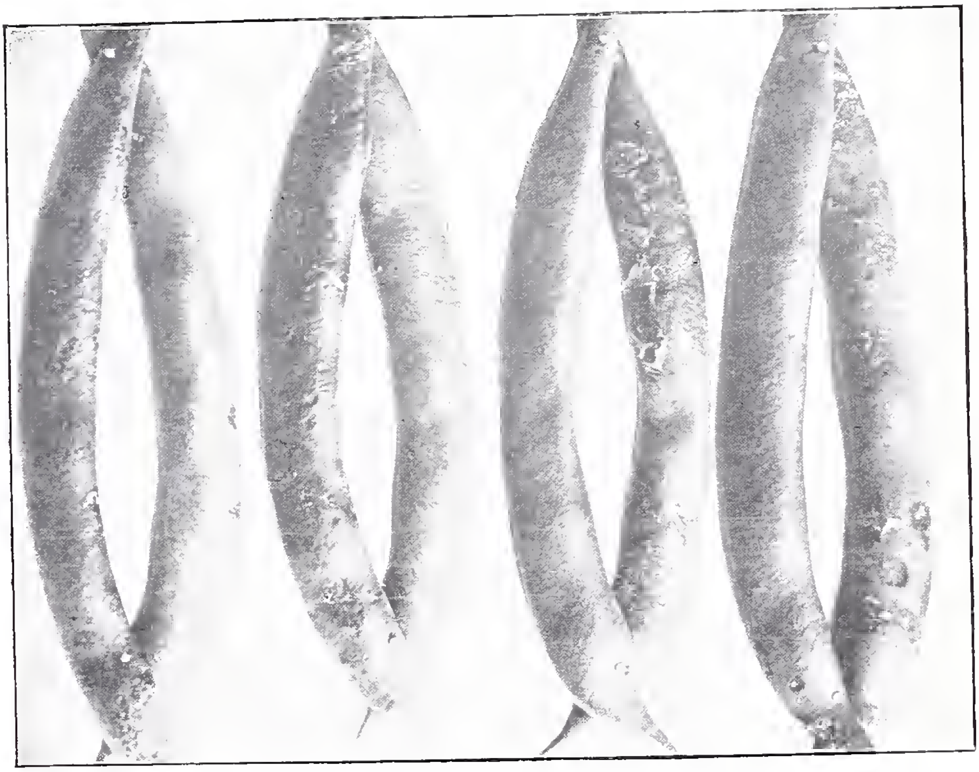

Fig. 15.—Four Pods of Green Flagolet Showing Bacteriosis upon the Side most Exposed to Sun, etc.

upon the Lima varieties, but now it is met with upon nearly all sorts, some kinds of the bush beans as the "green flagolet," being particularly susceptible to it. The appearance of a bean leaflet badly affected with the bacteriosis is shown in Figure 14. It produces large, irregular blotches in the leaves which become at first watery, then dry up, are very brittle and break to pieces.

The diseased pods become at first as if water logged, somewhat discolored and soon show an amber exudation of the bacteria upon the surface.

One of the most dangerous features in connection with this disease is, that the germs are carried over from one season to another in the beans themselves. If it were possible to detect and thereby reject all affected seed, it would make matters easier. Many seeds are worthless at harvest time, but others are only slightly infested, and it is these latter that do the most mischief. Great care should be taken with the beans used for seed, only the best being planted and, if possible, purchases should be made of those who have not

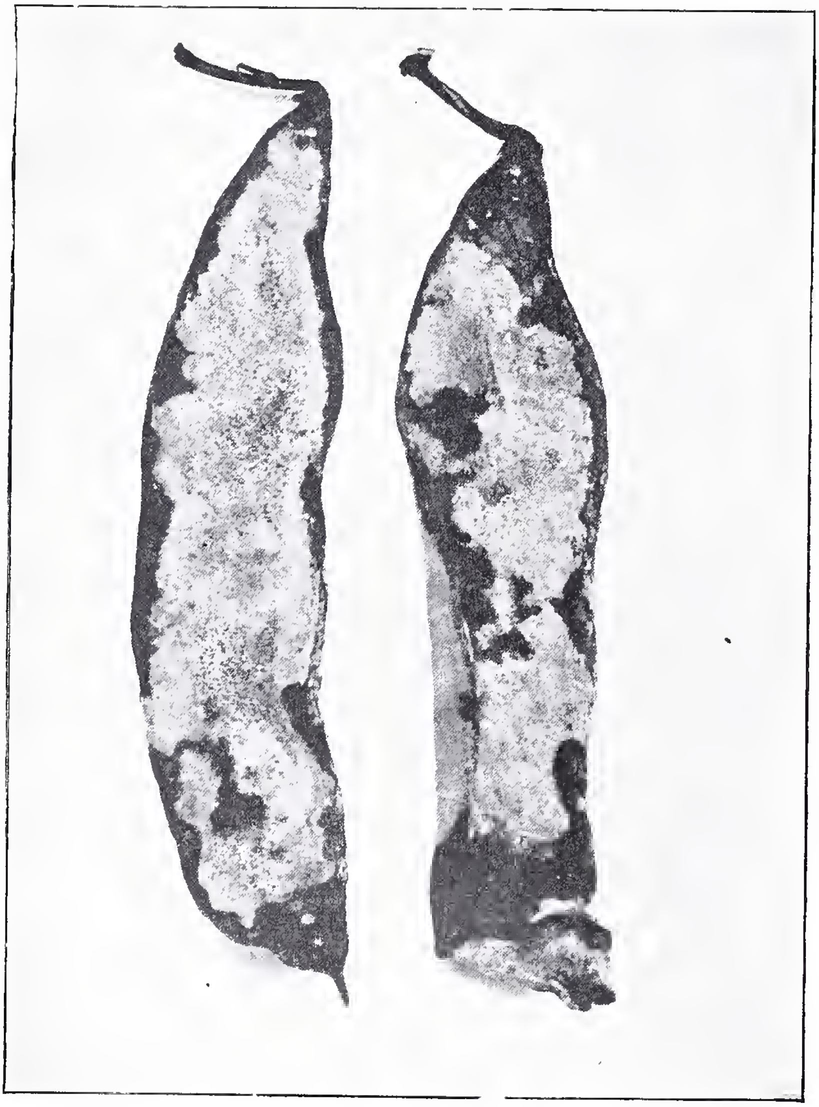

Fig. 16.—Two badly Mildewed Lima Beans.

had any bacterial trouble in the field. It is likely that the disease germs may remain in the soil, or with other plants upon the same area, for a long time.

Figure 15 shows four pods of the "green flagolet" showing bacteriosis upon the side most exposed to the sun. The plants had been bent by a storm, thus introducing conditions more favorable upon the upper than the lower side of the slanting pods.

Mildew of Lima Beans. (*Phytophthora Phaseoli* Thax.).

The lima bean plants in the Eastern States have of late years been badly attacked by a mildew. In some fields recently visited they were so badly attacked that few or no pods were picked from some of the fields. The mildew was worse with plants growing upon the rich lowland and where the same crop had been upon the ground the previous year. Figure 16 shows two badly mildewed pods.

Not only the young pods, but the whole flower clusters were destroyed and the dead tips of these stood up above the surrounding leaves of the hill of plants. One grower told me that late beans from the second planting were the most diseased and proved worthless.

In moist seasons it would seem best for lima beans to be put upon high ground, planted as early as possible and not upon old bean land.

FUNGOUS ENEMIES OF THE PEA.

There are several enemies of the pea, and late-grown peas are quite sure to suffer, while those sown early in the spring are not certain to escape. The most conspicuous trouble coming under the present subject is given first upon the list.

The Pea Mildew. (*Erysiphe Martii*, Lev.).

The mildew of the pea is a member of a large group of fungi infesting plants quite generally and causing damage to various crops, as, for example, the grape, cherry and, particularly, the gooseberry. The mildew of the last plant is so destructive that gooseberries are grown with great difficulty and uncertainty in many parts of the country, and particularly, the European sorts.

The mildew of the pea quite resembles that of the gooseberry, consisting first of a fine growth of microscopic threads over the leaves and vines, followed later by a multitude of minute dark bodies, which bear the spores. Leaves attacked by this mildew fail to attain their normal size and lose their full power for work, while the vines become weakened and the fruit shrivels and fails to develop plump seed.

It has not been attempted largely, and it may be that the crop is so bulky and comparatively low-valued, that for the mildew alone it might not pay to spray. However, as there are other fungous enemies to the pea, it may prove profitable to treat them all with the Bordeaux or other mixture of equal value.

Failure of Pea Seeds to Grow.

During the past year several complaints have come to hand of seed peas failing to produce a crop. The peas, as they came from the store, looked comparatively healthy, but were found to contain, upon inspection, about 18 per cent. of seeds more or less injured by insects —probably the pea weevil. These peas, when planted, failed, in a large part, to grow, and those that came above ground quickly showed signs of disease and finally, after a few blossoms, imperfect pods were produced but no crop was realized.

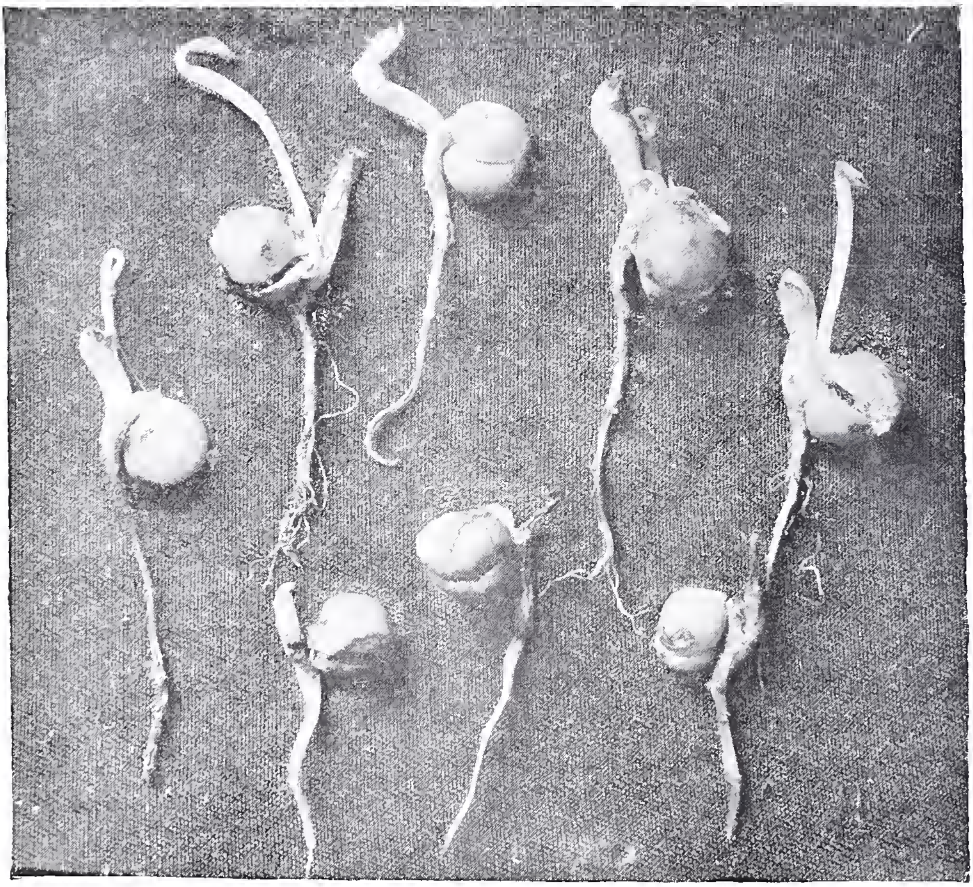

Fig. 17.—Bacterial Disease of Seedling Peas.

There are a number of reasons for this failure. In the first place, as before mentioned, a large per cent. of the peas are attacked by the weevil. These weevilled seeds usually do not grow. A thorough test of this matter has been made; the weevilled peas, those that were not at all broken or showed special signs of the work of the insect, have been planted and watched, and, as a rule, they failed even to show the first stages of germination. On the other hand, these weevilled peas quickly become the center of bacterial development, and shortly were exceedingly offensive. The sand employed was first burned to remove all organic matter, and afterwards moistened with distilled water. Perfectly healthy peas, so far as selection will determine, were planted in this soil in which the weevilled peas had been sown and also failed to produce good plants, while similar peas, placed in like conditions, save the previous occupancy of sand by weevilled peas, showed a comparatively healthy growth.

More than this, if in sterilized sand, watered with distilled water, peas be planted in pair, namely, a weevilled and a healthy one touching each other, both seeds of each set will fail to produce good plants. Healthy seeds again planted in the same soil developed a rank bacterial decay and a total failure in germination. One of the leading features of the study of peas was the secondary sprouts that were sent up after the primary one had become decayed by the Pythium or bacteria or both. Figure 17 shows the condition of several seedlings, four of which may be seen to have a second growth of stem, while in the others the germ is too far gone for any further growth.

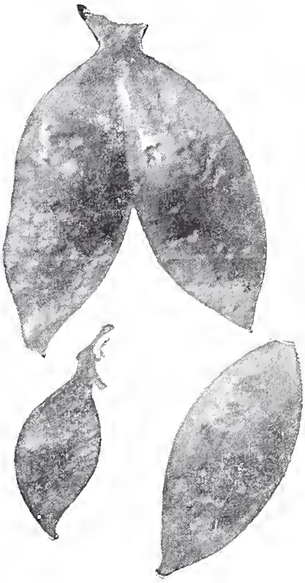

Fig. 18.—Pea-pods affected with Blight.

The conclusions seem clear enough that the weevilled peas are not only in themselves a source of loss in the seeds, but in seedlings they are the means of propagating a decay in other peas that would naturally grow.

Pea Leaf Blight.

In addition to the above-mentioned troubles, there is a third which shows itself upon the young leaves. This is one of the leaf blights, and has not been credited with doing serious damage to the peas in this country. Its first appearance is in the form of blighted patches of the young leaves, but the whole plant is apparently infested with the threads of this parasitic fungus. The attacked foliage turns to a sickly yellow before becoming brown, large spots appear upon the vines and the plant fails to attain its normal development. An examination determined that this fungus previously mentioned (*Ascochyta Pisi*, Leb.), is not confined to the foliage and vines; but the pods become very much spotted with the same disease, as shown in Figure 18. These pods, in their appearance, resemble very much the so-called pod spot of the bean, and might be easily mistaken for the same trouble. In the field where the experiments have been carried on, the total length of rows devoted to the peas being one hundred and fifty feet, there was not a single pod which obtained a length of more than an inch, and of course was of no account. These pods, usually containing no seeds and averaging less than an inch in length, were uniformly more or less spotted with the Ascochyta.

Further investigations of the peas grown have brought to light the fact that the seeds themselves, apparently healthy when placed in the ground, soon show patches and spots of a dark color, which are also the spore-bearing places of the same Ascochyta. Therefore, it has been shown that in this disease, which is strictly parasitic, the fungus is present in all parts of the plant, excepting possibly the root system, and including the seed itself from which the plant has grown, and possibly from which the fungus itself has spread and brought ruin.

LABORATORY STUDY OF FRUIT DECAYS.

Fresh native specimens in a pure condition—that is, decaying fruits having but one fungus present—were taken from field, orchard or market-stand, as case may be, and a portion of the decay transferred to a healthy fruit, or, as in many cases, only the spores of the decay fungus were introduced into the subject to be tested. While the work of inoculating was not confined to any one group of rot-producing fungi it is best in this discussion to confine our attention to the anthracnose alone, and only two genera of them, namely, the *Gloeosporium* and *Colletotrichum*. These differ from each other principally in the presence in the latter of dark hairs, which stand as bristles among the spore masses, giving the whole blighted surface more or less of a darkened appearance. The Gloeosporium are usually characterized by a pale pink color to the spore-bearing portions.

The work so far as it has gone, and it is far from being completed, may be represented graphically by a diagram (Figure 19), in which the several fruits treated are arranged in an oval and the successful inoculations are shown by lines drawn from the fruit yielding the rot, naturally to the ones which are susceptible under the conditions of inoculation.

There are two sorts of lines, the dotted ones representing the Gloeosporiums, or light-colored fungi, and the solid ones the Colletotrichums, which are usually dark, as above stated, because of the stiff black bristles. The arrow shows the direction in which the inoculation has gone.

It is quite natural to start with the apple in the consideration, and with the light-colored anthracnose known as the ripe rot (*Gloeosporium fructigenum*, Berk.). Up to this time the only other fruit upon which this fungus was known to grow is the grape, the Division of Pathology of the Department of Agriculture having recently established this fact. It was an easy matter to verify this work, but of more interest to find that when the virus was transferred to the flesh of the peach it quickly developed in a vigorous way, and produced a similar patch of decay not identical in appearance because of a difference in texture of the host, but the spore masses and spores were the same.

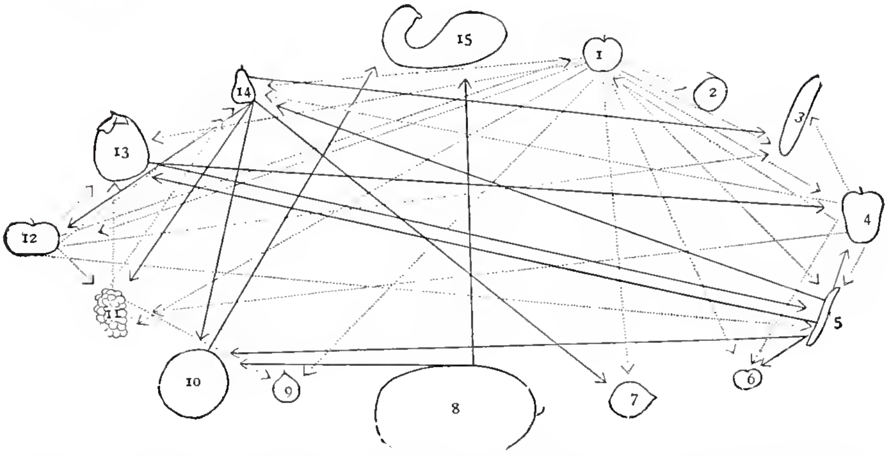

Fig. 19.—1, Apple.; 2, Peach; 3, Banana; 4, Pepper; 5, Bean; 6, Persimon; 7, Lemon; 8, Watermelon; 9, Quince; 10, Citron; 11, Grapes; 12, Tomato; 13, Eggplant; 14, Pear; 15, Squash.

Turning now to the tomato group, the chart shows that the dotted lines run to each of these, namely, the pepper, egg plant and the tomato. Noting the arrows in this connection, it will be seen that the native Gloeosporium of the pepper and of the tomato, supposed to be different species and distinct from the one upon the apple, were cultivated upon the latter fruit, where each produced the ripe rot of the apple.

Following the oval around to the right, beginning with the apple, it will be seen that, besides those fruits already mentioned, the arrows point to the banana, bean and lemon, all fruits representing widely different groups of plants.

The pepper has given its pink anthracnose to six, namely, the banana, pear, persimmon, apple, grape and bean. The dark species has been received from the egg plant and the bean.

In connection with the bean, the dark lines are most abundant, showing that here the genus Colletotrichum is quite at home. It sends this to pepper, pear, egg plant, citron and persimmon, and receives the same from the egg plant only—in this case an even exchange. The pink comes from pepper, apple and tomato.

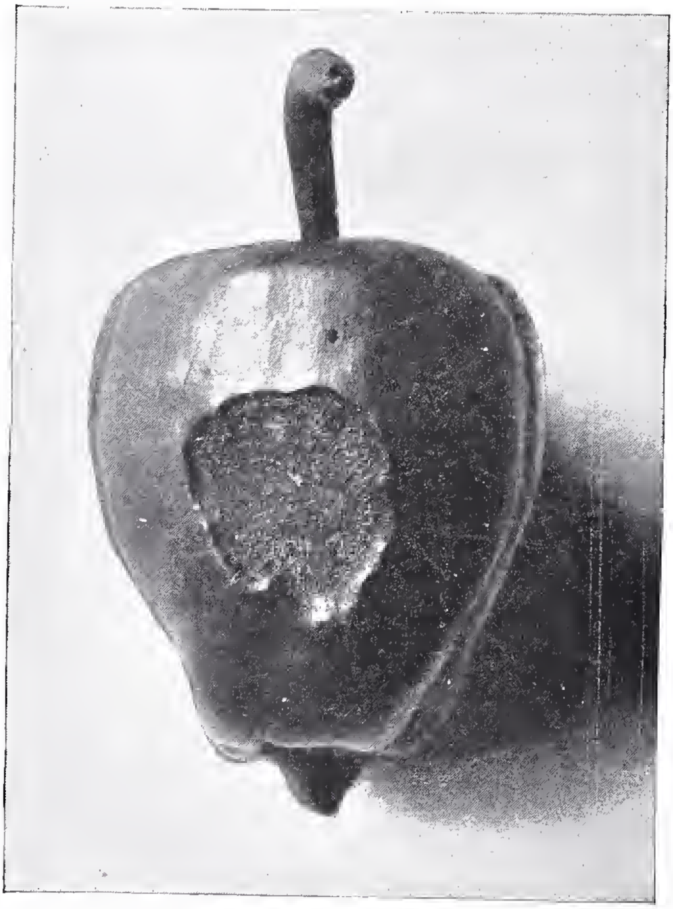

Fig. 20.—Pepper Anthracnose from Apple.

The watermelon has not been inoculated with anything, but its anthracnose has been carried to the squash and the citron.

The citron has only dark lines coming from the bean, melon and pear, and sends out its own to the squash. From the grape has gone out light lines to quince and egg plant, and similar lines run to it from the apple, pepper and tomato. One solid line runs to it, namely, from the pear.

The tomato exchanges the pink rot with the apple, sends it also to banana, bean, grape, egg plant and pear. It receives the dark lines from the pear.

From the egg plant goes out dark rot to pepper, and an exchange is made with the bean. It also receives the pink rot from the apple, grape and tomato. The pear sends its Colletotrichum to banana, lemon, citron, grape and pepper, and receives the same group from the bean. The pink rot comes from the apple, pepper and tomato. No attempt has been made to send anything out from the squash, and it has received the dark decay from the melon and citron.

Figure 20 was made from a photograph of one of the inoculations of the pepper ripe rot from that of the apple. The appearance, to the eye, of the anthracnosed pepper was quite different from that of the apple, but the conditions of flesh texture and character of the skin, etc., were very unlike, which accounted for the more rapid growth in the pepper and the greater shrinking of the diseased area.

However, the microscopic structures were the same in both and the individual acervuli similar. In an economic aspect the information has its value, as it shows a close connection between the anthracnoses of the several garden crops. That is, one fruit does not blight to its own kind alone. A decaying tomato or apple is neither its brother's nor its cousin's keeper.

FUNGICIDES AND SPRAYING.

The subject of spraying has been mentioned in connection with several of the diseases previously considered. The writer has tested a large number of fungicides for various truck crops and finds that the Bordeaux mixture is general satisfactory. It has not kept off all diseases, but this may be in part due to lack of information as to the best time to apply the remedy. The whole subject of fungicides is in its infancy and much remains to be learned.

Bordeaux Mixture:—The Bordeaux most generally employed the present season was prepared according to the following formula:

Copper sulphate (bluestone), ...	6 pounds.
Quicklime, ...	4 pounds.
Water, ...	60 gallons.

To dissolve the copper sulphate, it should be put in a bag of some coarse material and suspended so as to dip into water not more than two or three inches. Several pounds may be dissolved in this way within two or three hours, but if the entire quantity is at once immersed, much more time will be required, and if the crystals of sulphate be thrown loosely into water, a considerable proportion may remain undissolved in spite of long-continued stirring. It is well to suspend the bluestone in water, over night, and thus avoid any possible delay in the following day's spraying. Treated as above recommended, one pound of copper will readily dissolve in one gallon of water. The solution of the copper may be greatly hastened by the use of hot water. Solutions of copper sulphate, as well as the prepared Bordeaux, should be contained only in wooden, "granite" or copper vessels.

Lime slakes more thoroughly in hot water than in cold, and after slaking it should be diluted to a thin whitewash and strained through coarse sacking to remove all sediment. Bordeaux prepared by pouring copper into lime has been found to remain in suspension longer than when lime is poured into copper, and if the copper is about half as dilute as the lime the effect is better still. If, for example, sixty gallons of Bordeaux are to be prepared, slowly pour a ten-gallon solution of the required copper into twenty gallons of lime-wash, stirring thoroughly, after which the concentrated Bordeaux thus formed may be diluted to sixty gallons.

For small areas a five-gallon knapsack pump will be found most convenient; but for spraying orchards, vineyards or entire fields a force pump attached to a tank and mounted on wheels is necessary. Various sorts of spraying machinery may be obtained from a number of reliable firms through the country.

Soda-Bordeaux.—The Soda-Bordeaux differs from the common Bordeaux in that caustic soda (Sodium hydrate) is used instead of lime to neutralize the copper sulphate solution.

Ten pounds of soda will dissolve readily in two gallons of water, and should be kept in closed vessels, other than wood, which may be drawn from as desired. A two-gallon solution of the above will be sufficient alkali with which to prepare 455 gallons of the Soda-Bordeaux. This fungicide is made as follows:

Soda (lye),	1 pound.
Copper sulphate,	3 pounds.
Lime,	5 ounces.
Water,	30 gallons.

It was used upon various crops adjoining plants treated with the standard Bordeax, and it stood the test satisfactorily. In order to prevent the mixture turning brown, a small quantity of lime was used to neutralize any excess of acid, and in this way a permanent bluish color was obtained in the mixture. The only advantage claimed for this fungicide is the absence of a large part of the lime in the ordinary Bordeaux mixture, and it, therefore, may prove of considerable value as a fungicide in the fruit garden and vineyard, particularly when the fruit is nearing full size.

The writer has employed these two fungicides for several years with the various vegetable fruit crops treated in this paper, and can recommend them. Sometimes quite striking results have been obtained, especially with the anthracnose of the bean. There are some diseases of the pea that are unusually stubborn. It has been determined that beans may be grown for ten successive crops upon the same land with no serious decrease of crop, but with egg plants there is a deterioration after the third year. It seems to be true that the leguminous crops, like beans and peas, may be continued upon the same land while tomatoes, melons and such vegetable fruit plants need land new to them.